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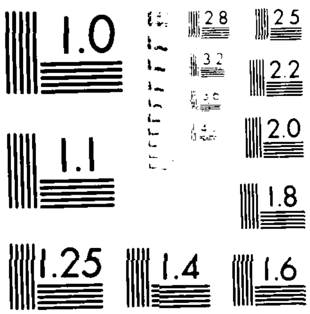

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EVALUATING THE USE OF TEMPORAL-SPATIAL PATTERNS FOR PERSONNEL SELECTION AND CLASSIFICATION

Don B. Croft
and
Richard E. Christ

Research Project Conducted under Grant AFOSR-81-0139
Air Force Office of Scientific Research

Training Systems Center
New Mexico State University
Las Cruces, NM 88003
October 1982

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The study identified associations between measures of performance on a temporal-spatial pattern recognition task with a battery of Air Force tests. The 101 subjects differed widely in their ability to correctly perform the tasks, and the 64 patterns also differed in difficulty level. Significant multiple correlations were obtained for predicting the number of correct patterns from the response time measures taken during task performance. The pattern performance measures also correlated significantly with the AF test battery. (cont'd)

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Abstract

The study identified associations between measures of performance on a temporal-spatial pattern recognition task with a battery of Air Force tests. The 101 subjects differed widely in their ability to correctly perform the tasks, and the 64 patterns also differed in difficulty level. Significant multiple correlations were obtained for predicting the number of correct patterns from the response time measures taken during task performance. The pattern performance measures also correlated significantly with the AF test battery. Correctly performing the pattern recognition task was related to general intellectual ability as well as a problem-solving or a "test-wise" factor. Additional study was suggested to validate the pattern performance measures with the on-the-job criteria.

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Evaluating the Use of Temporal-Spatial Patterns for Personnel Selection and Classification

Introduction

The Manpower and Personnel Division of the Air Force Human Resources Laboratory (AFHRL) has sponsored research to investigate, develop and evaluate computer-assisted testing procedures for personnel selection and classification. A major objective of the research program is developing measures of perceptual and psychomotor abilities for inclusion into batteries of psychological tests.

Recent research has demonstrated the efficacy of computer-assisted testing techniques as well as the use of measures of perceptual and psychomotor abilities. Three studies have shown that global measures of complex psychomotor performance yield measures of abilities which are untapped by conventional paper-and-pencil tests. (Hunter and Thompson, 1978; McGrevy and Valentine, 1974; Sanders, 1971) The scores obtained on computer-administered performance tests added significantly to the accuracy of paper-and-pencil tests for predicting graduation from undergraduate pilot training. Batteries of up to nine computer-administered performance tests have been developed by the Air Force for experimental use. (Hunter, 1975; McLauren, 1973) The test batteries included a variety of perceptual, memory, learning, and motor tasks. It was shown that performance on these test batteries is useful for predicting course grades for officer navigator training and for airmen technical training. (Hunter, 1977; McLauren, 1973) The U. S. Navy also has developed an experimental

performance test battery that is administered by computer. The Navy test battery measured two unique abilities, and substantially enhanced the predictive accuracy of paper-and-pencil tests for one occupational group. In addition, the measures were a useful supplement to paper-and-pencil tests for identifying personnel skilled for seven common job elements. (Cory, 1977; Cory et al, 1977)

While the investigations are very encouraging, additional research is required to fully explicate the value of computer-administered tests of complex human performance capabilities. Only a few potentially important abilities have been assessed using this approach; several domains of aptitude have not been assessed at all.

Historically, paper-and-pencil tests were assumed to measure individual differences in mental abilities or "traits," while performance tests were assumed to measure individual differences in perceptual-psychomotor abilities or "skills." In addition, a collection of relatively independent tests were employed to assess each trait or skill domain. Finally, the testing material and the response alternatives were generally limited to relatively simple, discrete events or series of discrete events. With one exception, the same assumptions and procedures are prevalent in the current operational testing environment. Due to methodological problems associated with the perceptual-psychomotor testing apparatus, the so-called apparatus tests were dropped from operational use in the mid-1950's. Hence, during the past 25 years, there have been no direct operational tests of perceptual-psychomotor abilities.

At least two reasons justify a re-examination of these strategies for personnel testing. First, modern computer-aided testing no longer imposes methodological limits in our attempt to improve personnel selection techniques.

The computer equipment is very reliable and easily portable. Furthermore, the hardware systems can be programmed easily to control the recording of complex responses made by the subject.

Second, contemporary theories of human information processing provide new insights for identifying important components of human capabilities. Equally important is the argument that human capabilities are not utilized in isolation, but instead they operate concurrently and in combination. As noted by Passy and McLaurin, (1966) the integrative behavior required of operators in complex man-machine systems makes it doubtful that performance on isolated tests provide the predictive efficiency required for selection purposes. Hence, from both a theoretical and a practical point of view, the independent assessment of mental traits and perceptual-motor skills is no longer desirable.

Purpose

The purpose of the study was primarily to determine if an association existed between responses to complex visual patterns and scores on a battery of cognitive tests commonly used by the Air Force. The responses to visual patterns require the operator to quickly and accurately perceive, and subsequently retreive and utilize information about temporal and spatial patterns from instruments in the external environment. Also the operator must make fast, accurate response decisions and generate smooth organized patterns of manual responses.

Objectives

As a means to provide additional information about responding to complex visual patterns the study has the following objectives:

1. assess the differences in performance of the subjects

2. describe the differences in the difficulty level of the patterns
3. identify performance and cognitive measures associated with correct pattern performance
4. determine if performance on the patterns is associated with scores on the Air Force Test Battery.

Rationale

Thus, the research which was conducted begins an investigation of the reliability and meaning of individual differences in performance on tasks incorporating temporal and spatial patterns of events. Performance in these types of tasks require skills which include a wide range of psychological concepts: each concept defines a process which is proposed to account for some specific aspect of human information processing activity. The information processing activities generally are considered to be organized into a hierarchy of skills. Successively higher levels in the hierarchy of skills are utilized to monitor, control, and organize more structured and coherent sequences of inputs and outputs.

Any attempt to develop a task battery to assess an individual's capability to acquire skill, in responding to visual patterns, must be sensitive to the hierarchical nature of skill components. In short, while the ultimate objective of the present line of research is to develop a task battery which will include relatively complex tracking and problem-solving tasks, the battery will also include more simple tasks. The experiment was designed to investigate the reliability and meaning of individual differences in performance in relatively simple tasks. Subsequent research may further expand and integrate the number and difficulty levels of component tasks.

Method

The experiment was conducted in cooperation with personnel and facilities at Lackland AFB. The 101 subjects were randomly selected from basic airman flights at the base, and Lackland research staff used the base computer apparatus to run the subjects. In addition, the Lackland research staff recorded the AF Battery Tests for the subjects. The data for each subject was recorded on a computer magnetic tape, and sent to the principal investigator for analysis at New Mexico State University.

Apparatus

The apparatus previously developed for the automated test research laboratory at Lackland AFB was used for the proposed research. The core of the apparatus consisted of a microprocessor system with disk storage and control capabilities. The microprocessor system was used to present repeating patterns of visual inputs on a cathode ray tube (CRT). A manual keyboard and a light pen were used by the subject to record responses.

Stimulus Patterns

Each temporal pattern used in the experiment consisted of a six-position pattern which replicated without a break while the subject viewed the presentation. The individual elements of the step function input appear as a short vertical line which moves in discrete jumps from one position to another along the horizontal axis of the CRT.

The population of stimulus patterns consisted of the 720 patterns which are possible in a sequence of six events. If the positions are numbered one through six from the left-most position throught the right-most position, one very easy pattern consists of the sequence 1-2-3-4-5-6.

Equivalences in objective structure among the 720 different sequences were derived by varying the starting point of the sequence of positions and by generating complementary patterns. Hence, the sample pattern given above generates 11 other equivalent patterns when starting points are varied (e.g., 2-3-4-5-6-1 and 3-4-5-6-1-2), and when the complement (or mirror image) of each pattern is generated (e.g., 6-5-4-3-2-1 is the complement of 1-2-3-4-5-6). There are 56 basic patterns like the example given above, each of which generated 12 equivalences by considering starting points and complements. Another eight basic patterns generated only six equivalences each, since the complements of these patterns begun at one starting point are patterns already defined by other starting points (e.g., the complement of the pattern 1-2-3-6-5-4 is 6-5-4-1-2-3 which is the original pattern begun at the fourth position). Thus, a total of 64 different patterns were selected for presentation to the subjects.

Experimental Procedure

The 64 basic patterns were presented to all subjects. To permit the subject to organize the pattern beginning with any starting point, the pattern was initially presented at a very fast rate--too fast for the subject to perceive any structure in pattern, and hence, too fast for the subject to be biased by the objective starting point used for presenting the pattern. Then, over a series of successive cycles of pattern presentation the rate of presentation was reduced until the subject was able to identify the pattern.

As soon as the pattern could be described, the subject lifted the light pen from a predesignated area on the CRT, which terminated the

presentation of the pattern. Then, the subject described the pattern by tapping the light pen to six position markers displayed on the CRT in the sequence that was recalled.

There were three major dependent measures in the experiment: (1) the time required by S to indicate that the pattern was identified, (2) the accuracy of the identification, and (3) the time required by S to complete the response.

Air Force Test Battery

A series of paper-and-pencil tests were administered to the subjects. The particular tests covered a wide range of abilities. Specifically, the following ASVAB and AFQT tests were administered:

1. Administration
2. Electronics
3. General
4. Mechanical
5. AFQT

Results and Discussion

Although the primary purpose of the study was to determine if the measures of performance on the temporal-spatial patterns were associated with scores on the AF battery of tests, the data also were analyzed to report if the subjects differed in their performances on the patterns, if the patterns themselves had differing difficulty levels, and if the measures obtained predicted how well the subjects did, indeed, perform the pattern recognition tasks.

Differences in Berformance of Subjects

The descriptive statistics presented in Table 1 provide an indication of the characteristics of the subjects and the subjects performance on the pattern recognition tests. The average age of the subjects was approximately 20, which is typical of most air force cadets. The ASVAB and AFQT test scores were approximately equal to the mean score for air force cadets, and thus the sample was representative of typical air force cadets.

The subjects responded correctly to an average of 37 out of the 64 different pattern recognition tasks, and considerable variance existed among the subjects. (Standard deviation = 16.6 and range = 3-61) thus, the subjects did not miss all the patterns nor did they correctly respond to all 64 tasks.

It was possible for subjects to get one or more elements of the pattern correct for a total of six elements. A correct score was given only if the subject got all six elements correct (total correct TC). Thus, as an index (Total positions correct, TPC) of partial learning the average number of elements in the pattern which the subject marked correct also was computed. Note that the sample of subjects correctly

Table 1

Mean and s.d.'s for subjects for all measures (n = 101)

Independent Variable	Mean	s.d.
1. Administration	62.8	17.9
2. Electronics Information	59.7	22.0
3. General Science	61.5	19.8
4. Mechanical	52.4	27.1
5. AFQT	63.4	18.6
6. Age	19.7	1.9
7. TPC	279.7	82.2
8. TC	37.0	16.6
9. RLI	24.5	10.8
10. RLC	22.3	9.6
11. RLT	23.5	10.3
12. RTI	7.7	2.4
13. RTC	5.9	1.8
14. RTT	6.5	1.6

responded to 279.7 out of a total of 384 elements. The variability of the subjects was large (s.d. = 82.2).

The response latency total (RLT) was measured from the time of stimulus presentation until the first response of the subject to record the elements of the pattern. Response time total (RTT) was measured from the time the first element in the pattern was recorded until all 6 elements had been completed. Note, that it took longer for subjects to identify the pattern than it did for the pattern response to be recorded (RLT = 23.5 secs. and RTT = 6.5 secs.)

Response latency times were computed separately for correct and incorrect responses. Note, that in Table 1 an incorrect response took longer than did a correct response (RLT = 24.5 secs. and RLC = 22.3 secs.). However, the difference was not significant (t = 1.53). On the other hand, subjects who gave correct responses also recorded their responses faster than those making incorrect responses (RTC = 5.9 secs. and RTI = 7.7 secs.). The t of 6.00 was significant at the .05 level.

Differences in Pattern Difficulty

Next, the groups' responses to each of the 64 different patterns was computed. The analysis is presented to show differences in the difficulty of the patterns. Note in Table 2 that for pattern 1-2-3-4-5-6, a relatively easy one, 80 subjects responded correctly to the pattern. However, for pattern 1-3-4-5-2-6, a difficult pattern, only 33 subjects responded correctly. An average of 58.5 subjects out of 101 responded correctly to the patterns. Thus, the average difficulty level of the patterns was .58 and ranged from a low of .33 to a high of .80.

Table 2

Average response times and number correct for each pattern (n = 101).

No.	Pattern	No. Corr.	Aver Posn. Corr	Resp. Late Inco.	Resp. Late Corr	Resp. Late Total	Resp. Time Inco	Resp. Time Corr.	Resp. Time Total
1	134526	33	4.0	22.4	21.9	21.1	9.2	7.7	8.7
2	143526	40	4.0	28.2	23.2	25.0	10.2	9.1	9.8
3	123456	80	5.0	26.1	9.0	12.8	8.2	5.9	6.5
4	134562	47	4.0	18.4	13.5	16.0	7.9	6.2	7.1
5	154632	38	3.0	27.1	22.5	25.4	8.5	7.2	8.1
6	152346	46	4.0	20.4	18.3	19.4	6.6	6.6	6.6
7	156243	35	3.9	28.6	22.0	26.4	9.1	6.9	8.3
8	123654	53	4.0	22.4	14.1	18.1	8.2	5.9	7.0
9	124365	49	4.0	24.8	22.8	23.8	8.2	6.8	7.5
10	156423	37	3.0	32.2	28.0	30.5	8.9	6.7	8.1
11	132645	41	4.0	29.9	25.1	27.8	8.2	6.6	7.5
12	143256	52	4.0	29.1	20.6	24.6	8.1	6.4	7.2
13	146523	55	4.0	34.9	28.3	31.5	8.8	6.5	7.6
14	164523	46	4.0	29.3	30.0	29.6	7.6	6.4	7.1
15	146532	51	3.9	31.7	25.0	27.9	9.4	6.5	8.0
16	143265	63	5.0	35.5	22.3	27.3	7.7	6.2	6.8
17	126435	51	4.0	29.6	26.7	28.1	7.7	6.3	7.0
18	142536	56	4.0	30.1	29.0	29.4	11.9	6.7	8.7
19	135426	61	4.0	28.3	23.6	25.4	8.1	5.9	6.7
20	142563	46	4.0	32.5	30.4	31.5	7.8	7.1	7.5
21	142635	57	5.0	30.4	26.9	28.5	7.4	6.5	6.9
22	153624	46	4.0	33.5	29.5	31.1	7.2	6.9	7.0
23	145326	66	5.0	24.9	22.2	23.2	6.6	6.1	6.3
24	142365	59	5.0	22.0	21.5	21.7	6.1	5.2	5.6
25	143562	51	4.0	28.1	21.2	25.3	6.2	5.9	6.2
26	125643	64	4.9	26.3	17.8	20.9	6.3	5.6	5.8
27	153246	53	4.0	29.1	25.3	27.2	6.7	6.4	6.5
28	154236	57	5.0	30.0	22.5	25.8	6.5	6.1	6.3
29	132456	74	5.0	24.4	15.9	18.3	7.7	4.7	5.5
30	123654	77	5.0	18.6	14.3	15.5	6.5	4.7	5.1
31	152634	46	4.0	28.4	25.7	27.2	6.9	6.0	6.5
32	143652	58	4.0	26.2	25.0	25.4	7.1	6.3	6.6
33	126245	68	5.0	34.3	22.9	26.7	13.4	5.8	8.3
34	163254	56	4.0	26.5	23.3	24.7	6.9	6.0	6.4
35	165423	78	5.0	26.8	16.5	18.8	6.6	5.1	5.4
36	132564	78	5.0	21.3	16.6	17.7	5.7	5.2	5.3
37	124635	62	5.0	26.0	18.2	21.2	8.1	5.7	6.6
38	145263	60	4.1	30.3	24.5	27.6	7.3	6.1	6.7
39	145632	71	4.9	26.2	17.1	19.4	5.6	5.6	5.6
40	156324	54	4.0	27.5	23.7	25.6	7.3	5.9	6.5

Table 2 (Continued)

Average response times and number correct for each pattern (n =101).

No.	Pattern	No. Correct	Aver. Posn. Corr.	Resp. Late Inco.	Resp. Late Corr.	Resp. Late Total	Resp. Time Inco.	Resp. Time Corr.	Resp. Time Total
41	123645	54	5.0	27.4	15.2	18.4	6.5	4.9	5.4
42	126543	73	5.0	26.2	17.1	20.0	6.4	4.8	5.3
43	163542	64	3.9	27.2	27.0	26.7	6.9	6.3	6.6
44	125436	68	4.9	26.1	19.5	21.6	6.5	5.6	5.9
45	152643	52	4.0	26.5	26.0	26.4	6.2	6.1	6.2
46	154326	70	4.9	21.9	18.3	19.6	6.3	5.2	5.6
47	126453	68	5.0	31.5	20.8	24.4	6.9	5.6	6.0
48	136524	56	4.0	24.6	22.3	23.8	7.7	5.7	6.6
49	136254	65	5.0	27.0	20.1	23.1	5.7	5.2	5.4
50	164253	57	4.0	28.4	24.9	26.3	7.4	6.1	6.6
51	146235	71	4.9	24.7	22.8	23.4	5.9	5.7	5.6
52	134256	65	4.9	28.2	19.8	22.9	6.8	5.7	6.0
53	153426	66	4.9	24.9	20.4	22.2	6.9	5.6	5.9
54	165324	57	4.0	29.8	19.6	24.0	6.1	5.3	5.8
55	154623	53	3.9	24.6	23.3	23.9	7.0	5.5	6.1
56	124653	61	5.0	21.4	20.1	20.6	5.8	5.2	5.6
57	165342	61	5.0	25.4	17.1	20.4	6.4	5.2	5.7
58	135642	64	4.8	21.9	20.0	21.0	6.3	5.2	5.8
59	124653	71	5.0	20.4	17.3	18.4	5.3	4.7	4.9
60	162534	69	5.0	20.9	22.6	22.0	5.9	5.2	5.4
61	135264	60	4.0	25.0	22.0	23.2	5.5	5.2	5.3
62	135624	69	4.9	20.7	15.5	17.2	5.9	4.3	4.8
63	154362	64	4.9	21.2	20.2	20.7	6.6	5.2	6.0
64	125463	70	4.9	22.7	19.4	20.6	5.4	4.7	4.9
Mean		58.5	4.4	26.6	21.6	23.5	7.3	5.9	6.5
s. dev.		10.2	.6	4.0	4.4	4.2	1.4	.8	1.0

A frequency distribution of the number of correct responses to the 64 patterns is presented in Appendix A. The distribution is remarkably flat, and there was little overlap among the number of correct responses to each pattern. In short, the difficulty of each pattern was different from all others, and the set of 64 patterns ranged across a wide variety of difficulty levels.

Predicting Correct Scores on the Pattern Performance Tasks

A Regression analysis was conducted to identify the relationship between the response times and the ASVAB and AFQT scores with the number of total patterns correct as the dependent variable. A second analysis was done withe the number of total positions correct as the dependent variable.

A stepwise multiple regression analysis UCLA Computer Program, BMD02R, was employed to compute the standard partial regression coefficients and the total multiple correlations for the set of independent variables. The results of these two separate analyses are presented in the Table 3. Note, that the multiple correlations are high, .66 and .69 respectively for predicting total correct and total positions correct. The step in the multiple regression technique in which all independent variables had significant (.05 level) partial correlations with the dependent variable was the one selected for presentation in Table 3.

The analysis of the variable which predicts the total correct score shows that, in general, subjects who recognized the pattern fast (RLT = -.41), and recorded their responses quickly (RTT = -.37) obtained the highest number of patterns correct.

Nevertheless, longer times to recognize the pattern (RLC = .14) and then getting it correct also were associated with a high total correct

Table 3

Significant partial correlation of pattern performance measures and cognitive tests with total patterns and positions correct (n = 101).

Independent Variables	Dependent Variable Total Patterns Correct	 Total Positions Correct
1. Administration		
2. Electronics_Information		
3. General Science	.28	
4. Mechanical		.28
5. AFQT		
6. Age		
7. TPC		*
8. TC	*	
9. RLI		
10. RLC	.14	.19
11. RLT	-41	-45
12. RTI	.20	.27
13. RTC		
14. RTT	-37	-28
Mult. R	.66	.69

* omitted

score.

In addition, taking a longer time (RTI = .20) to record an incorrect answer also was associated with obtaining a high number of the pattern correct. Thus, it appears that mediational activity during presentation (acquisition) of the pattern as well as during recording (recall) of incorrect responses contributes to obtaining a high number of the patterns correct.

Virtually, the same relationships were obtained when the total positions correct was the dependent variable. However, it is important to note that the General test correlated significantly (r = .28) with the total patterns correct, and that the Mechanical test correlated significantly (r = .23) with the total positions correct. The General test correlated very high with the AFQT (r = .93) the Mechanical test correlates moderately high (r = .53) with the AFQT. Thus, the General test may be related to overall ability which facilitates obtaining a high number of the patterns correct. On the other hand, the Mechanical test may measure the mechanical ability to respond to elements in the pattern.

In summary, short recognition times and short recording times were positively associated with the total number of patterns obtained correctly by the subjects. In other words, subjects who recognized the pattern fast and quickly recorded it obtained a higher number of patterns correct.

However, it is important to note, that taking a longer time to recognize the pattern was positively associated with a higher number of total correct patterns. In addition, taking a longer time to record incorrect patterns was positively correlated with the total number of patterns correct. Mediation, which facilitates learning, appears to occur during acquisition as well as recall.

Table 4

Partial correlation coefficients between pattern performance and Air Force Test Battery.

Independent Variables	Dependent Variables				
	Administration	Electronics	General Sc.	Mechanical	AFQT
1. Age	.29				.13
2. TPC		.35		.40	
3. TC			.38		.34
4. RLC	-.22				
5. RLI		-.10	-.16		-.11
6. RLT		.15	.16		.15
7. RTI					
8. RTC					
9. RTT				-.19	
Mean R	.30	.39	.44	.44	.43

Predictors of the Air Force Test Battery Scores

The relationship between measures of responses to the patterns and the battery of Air Force tests was computed by employing a stepwise multiple regression analysis. The subjects' age also was included in the set of independent variables. All of the standard partial regression coefficients for the independent variables are significant at the .05 level. Note, too that the multiple correlation coefficients ($R = .30$ to $.44$) are significant at the .05 level, and sufficiently high to warrent analysis.

Age ($r = .29$) and taking a short time to acquire the correct pattern (RLC, $r = -.22$) were significantly associated with a high score on the Administration test. In other words, the older subjects who could quickly acquire the pattern correctly were the ones who scored highest on the Administration test.

For the Electronics test, subjects who spent a longer time acquiring the pattern (RLT, $r = .15$), but a shorter time watching patterns that were learned incorrectly (RLI, $r = -.10$) and in addition, obtained a high total for number of positions correct (TDC, $r = .35$) were the ones that scored high on the Electronics test. In short, the subjects minimized acquisition time on patterns they got incorrect and spent more time on the patterns they did get correct in order to obtain a high score on total number of positions correct.

Again, for the General test subjects minimized acquisition time on incorrect pattern responses (RLI, $r = -.16$) but did take a longer amount of time during the presentation to acquire the pattern (RLT, $r = .15$). This strategy was helpful for them to obtain a high total correct score.

The total correct score had the highest correlation with the General test (r = .38), thus, subjects scoring high on the General test appear to have high ability to respond correctly to the patterns, and minimize the time acquiring patterns they will get wrong.

The analysis of predictors of the Mechanical test showed that total positions correct (r = .40) and the total time it took to complete the response during recall (RTT, r = -.19) were correlated significantly with the Mechanical test. Thus, subjects who obtained a high number of positions correct, and took a short time to manually complete the responses were the ones who attained high scores on the Mechanical test. Thus, speed in recording the response helped subjects score high on the Mechanical test.

The pattern of correlations for the AFQT test was similar to the correlations for the General test. However, age (r = .13) was also a contributor to a high score on the AFQT. Thus, the older subjects scored higher on the AFQT. The correlations indicated that older students who obtained a high total correct on the patterns,(TC, r = .34) spent a longer time during pattern acquisition (RLT, r = .15) but minimized the time they spent acquiring incorrect patterns (RLI, r =-.11) were the ones who scored the highest on the AFQT.

It is important to note, that total positions correct and total patterns correct correlate highly, (r = .96). Therefore, one or the other as the significant predictor for the AF Battery tests makes little difference; instead it is simply the ability to make a correct response to the patterns.

In short, the analysis indicated that the pattern performance measures were moderately high predictors (aver. r = .40) for the AF Battery tests.

Generally, subjects who spent a longer time during acquisition of the pattern, but minimized the acquisition time on difficult patterns in order to obtain a high total correct score were the ones that obtained high scores on the AF Battery tests.

Summary and Conclusions

The Air Force Office of Scientific Research supported an exploratory project to study measures associated with responding to temporal-spatial patterns. An experiment was designed to show the feasibility of using the patterns with computer presented stimuli and equipment to automatically record the responses of subjects as well as to identify if responses to the patterns were associated with other performances, measures and paper-and-pencil tests of cognitive abilities. A summary of the study, a review of findings and recommendations for further research are presented.

Summary

The study was designed to identify if an association existed between measures of performance on a pattern recognition task and selected paper-and-pencil measures of cognitive abilities. In addition, the study provided information about the nature of the performance tasks. Specifically, an analysis was conducted to report if the patterns differed in difficulty, and if the measures differentiated among individuals.

One hundred and one subjects were presented a repeating pattern of short vertical lines which moved in discrete jumps from one to another of six positions. When the subject identified the pattern, a light pen was used to replicate the pattern. A total of 64 different temporal-spatial patterns were presented. A computer controlled the presentations and recorded the data for each subject. The data included the amount of time the subject observed the pattern before responding, the length of time it required for the subject to complete the six element response, a score of one was recorded if the subject reproduced the pattern correctly, and a

partial score also was recorded which indicated the number of elements the subject reproduced correctly. The data also included scores on the ASVAB and AFQT as well as the subjects' age.

The subjects differed widely in their ability to perform the tasks correctly. The sample responded correctly to an average of 37 presentations. The Standard deviation for the group was 16.6 and the range of scores was from 3 to 61 presentations correct. Response latency, the length of time the subject watched the repeating pattern (acquisition), required an average of 23.5 seconds, and the standard deviation for the group was 9.6 seconds. Response time, the time required for the subject to complete the response (recall) required an average of 6.5 seconds, and the standard deviation for the group was 1.6 seconds. It was concluded that individuals differ widely in their reponses to the patterns both in ability to correctly reproduce the pattern as well as the time it took for them to respond.

An analysis of the groups responses to each of the 64 patterns was conducted to determine if the difficulty of the patterns differed. The average difficulty of the pattern was .58 and the range of scores was .33 to a high of .80. It was concluded that the patterns had widely different difficulty levels.

Separate multiple regression analyses were computed to report the association of the reponse time measures, the ASVAB and the AFQT test scores with the total number of patterns, and the total number of positions reproduced correctly. The multiple correlations of .66 and .69, respectively, were significant and very high. The response time measures correlated more highly with the total correct scores than did the AF Test Battery. In general, subjects who learned the pattern fast and quickly recorded their responses obtained the highest number of total correct on the

pattern performance tests. This finding indicates that performance on the patterns is highly related to general intellectual ability. Separate multiple regression analyses were computed using response time measures, total correct scores, and age to predict the ASVAB and AFOT scores. The multiple correlations ranged from .30 to .44, and indicated a significant and moderately high association of the pattern performance measures with the AF Battery tests. In general, subjects who spent a longer time during acquisition of the pattern, but minimized the acquisition time on a difficult pattern in order to obtain a high total correct score on the patterns were the ones that obtained high scores on the AF Battery tests. This finding indicates that a "test wise" factor is associated with performance on the pattern recognition tasks.

Conclusions

The findings of the research indicated that temporal-spatial pattern perception has a high potential for identifying higher order cognitive skills which are associated with existing tests of mental abilities, as well as other performance measures. Computer programs and testing apparatus have been developed which easily present the stimuli and record the subjects responses on magnetic tape. Individuals differ widely in their ability to correctly reproduce the performance tasks, and the stimuli, themselves, differ widely in difficulty levels. The findings indicate that high scores on the pattern performance tests is related to general intellectual ability as well as a problem solving or "test wise" factor.

Additional study is suggested to validate the responses to the pattern with other measures of individual performance. Likely criteria of individual performance includes supervisory ratings, and on-the-job performance measures.

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APPENDIX A

Distribution of Pattern Difficulty (n = 64)

Number of Subjects Correct on Pattern	Frequency of Number Correct
80	1
79	
78	11
77	1
76	
75	
74	1
73	1
72	
71	111
70	11
69	11
68	111
67	
66	11
65	11
64	1111
63	1
62	1
61	111
60	11
59	1
58	1
57	1111
56	111
55	1
54	11
53	111
52	11
51	111
50	
49	1
48	
47	1
46	11111
45	
44	
43	
42	
41	1
40	1
39	
38	1
37	1
36	
35	1
34	
33	1

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